The University of Sydney
Plant Breeding Institute Cobbitty
Cereal Rust Laboratory

2005-2006 CEREAL RUST SURVEY ANNUAL REPORT

I. SUMMARY

Wheat Stem Rust Stem rust was first detected in WA at Carnarvon in mid August, and then at Geraldton in mid September. The most commonly isolated pathotypes from WA were the VPM-virulent pt 34-1,2,7 +Sr38, and the Wyalkatchem pt 98-1,2,3,5,6,7. The Oxley pt 343-1,2,3,5,6 was also isolated from WA. Stem rust was detected in SA and Vic in November, in breeders' plots and in several crops of Yitpi. The only pts isolated from these samples were 34-1,2,7 +Sr38 and a single isolate of 98-1,2,3,5,6.

Wheat Leaf Rust The predominant pt isolated from WA was 104-1,2,3,(6),(7),11 +Lr37, which was also widespread in the east. Also isolated from the east were pts 104-1,2,3,(6),(7),11; 104-1,2,3,(6),(7),11,13 (the *Lr24*-virulent pt); 104-1,2,3,(6),(7),9,11, and 2 new pts that appear to have originated from outside Australia. The first pt, 10-1,3,9,10,11,12 (the "Mackellar" pt), isolated from Bairnsdale (Vic) in late 2004, was isolated from other locations in Vic and in NSW in 2005. This pt combines virulence for *Lr1* and *Lr13*. The second pt, 76-3,5,9,10 +Lr37, was first isolated from Inverleigh (Vic) and then from other locations in Victoria and NSW. It combines virulence for *Lr13* with *Lr37*, making it potentially virulent on Braewood, H46 and Rudd. A variant of the Mackellar pt with virulence for *Lr15* was also isolated.

Wheat Stripe Rust The epidemic began with first reports in June in southern NSW on long season wheats, and then spread slowly throughout south eastern Australia during winter. The disease spread rapidly in spring in this same region and then appeared to move into the neighbouring regions to the north (Qld), south (Vic) and west (SA). The epidemic in WA was late developing and less intense than in previous seasons. Widespread use of fungicides was again a feature of management decisions for disease control. Pt 134 E16 A+ continued to dominate and the VPM pt, 104 E 137 A-, Yr17+, was also detected at low frequency. A new pathotype with virulence for *Yr10* was identified from SA. This pathotype, designated 150 E16 A+, is a single step derivative of 134 E16 A+. It is unlikely to cause serious problems for bread wheats since *Yr10* is not widely deployed. However this pathotype is also virulent on *Yr24* and this may have some implications for durum wheats.

Oat Stem Rust Although sample size was larger than 2004, the pathogen continues to be at very low levels. Virulence for *Pga* was detected again in 2005, after failing to be detected in 2004. Although Pga varieties will be expected to perform well, it is likely that if pathogen population size increases, then this resistance will again become less effective.

Oat Leaf Rust Forty six samples of leaf rust on oats were received. Pts isolated from SA and WA tended to be less virulent than those isolated from NSW and Qld, with the most common being pts 0001-0 and 0000-2. Virulences were again isolated for the cultivars Bettong, Barcoo, Graza 68, Gwydir, Moola, Nugene and Warrego. Two new pathotypes combined virulence for *Pc68*, Nugene and Warrego.

Barley Stem Rust There were no reports of barley crops affected by stem rust in 2005. Samples received from Qld were predominantly the "scabrum" stem rust pathogen, with 3 samples also comprising low levels of the "Oxley" wheat stem rust pt 343-1,2,3,5,6.

Barley Leaf Rust Twenty seven samples were received. The only pts isolated from WA were 5453P- and a presumed mutational derivative 5453P+. Both pts were also isolated from the east along with pts 5652P+ and 220P+. Pts 5453P- (first isolated from WA) and 5652P+ (first isolated from SA) were common in Qld, indicating that they are now well established in this region.

Barley grass stripe rust Although sample numbers were modest, isolates were commonly recovered from barley grass and certain barley cultivars in southern NSW and Victoria. No crop losses were reported. There have been no reports of stripe rust on barley grass or barley from Western Australia.

Triticale and Rye Rusts With the exception of several stripe rust samples in triticale, there were no reports of rust in commercial crops of triticale or rye in 2005.

II. DETAILED REPORT

INTRODUCTION

Rust surveys or inspections conducted by PBI staff during 2004-05 included:

Central, Southern NSW	17-19 August	Colin Wellings
Northern NSW	10-15 October	Colin Wellings
Central NSW	28-31 October	Colin Wellings

SEASONAL CONDITIONS

The early part of the 2005 season was unusually warm and dry, whereas the latter part brought widespread and above average rainfall. In total however, cropping regions experienced another year of below average rainfall. The low rainfall in the January-May period was exacerbated by unusually warm conditions and increased evaporation rates. The Bureau of Meteorology reported the annual mean temperature across Australia was the warmest on record.

South eastern districts in eastern Australia experienced very warm and dry conditions at the beginning of the season. An exceptionally warm April was compounded by a very dry May, and this led to delayed plantings. However, the warm conditions also maintained higher soil temperatures, so that crops sown on near record June rain were able to establish quickly. Follow up rain through to October combined with mild winter temperatures encouraged rust development.

In contrast, Western Australian cropping districts received above average rainfall in the April-May period, leading to ideal conditions for early crop establishment. Temperatures remained generally on average and even slightly below average in the Great Southern, and consequently yields were expected to be very good.

WHEAT RUST PATHOGENS

Wheat Stem Rust (caused by *Puccinia graminis* f. sp. *tritici*)
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Epidemiology and Pathotype Distribution

Wheat stem rust was first detected in WA at Carnarvon in mid August, and then at Geraldton in mid September, but incidence remained generally low throughout this state during the remainder of the season. Four pathotypes were identified from the 33 samples that were forwarded, of which the most common were the VPM-virulent pt 34-1,2,7 +Sr38 (12 isolates) and the Wyalkatchem pt 98-1,2,3,5,6,7 (10 isolates). Single isolates of the Oxley pt 343-1,2,3,5,6 (Carnarvon) and pt 34-2,7 (Pithara) were also isolated from WA.

In eastern Australia, stem rust incidence was very low in all regions, with only 18 samples of stem rusted wheat being received. Three of these samples failed to yield a viable isolate (Table 1), and only three pathotypes were identified from the remaining 15 samples: the Oxley pathotype (343-1,2,3,5,6), isolated from experimental plots in Queensland (Wellcamp and Warwick), the Paterson pathotype (98-1,2,3,5,6), isolated from a single sample collected at Penong (SA), and the VPM-pathotype 34-1,2,7 +Sr38, isolated from samples collected in Victoria and SA where it was found in some crops of Yitpi. All samples forwarded from SA and Victoria were identified as pt 34-1,2,7 +Sr38 (12 isolates) or the Paterson pt 98-1,2,3,5,6 (1 isolate from Penong) (Table 1).
Significant amounts of self sown wheat became established on the Erye Peninsula in early 2006, and stem rust was found at a number of locations in March. All samples forwarded in early 2006 were identified as pt 34-1,2,7 +Sr38.

Notes on the Pathotypes Isolated

The five pathotypes isolated during 2005-06 are believed to belong to one of two clonal lineages:

1. The “race 21” lineage, established following the introduction of pt 21-0, which was first detected in 1954-
    - Pt 34-2,7 — Derived from pt 21-0 via step-wise acquisition of virulence for *Sr5*, *Sr11* and *Sr15*.
    - Pt 34-1,2,7 +Sr38 — The “VPM” pathotype. Derived from pathotype 34-2,7 via step-wise acquisition of virulence for *Sr6* (to give pt 34-1,2,7) and then *Sr38*.This pathotype was first detected in WA in 2001, and presumably spread to eastern Australia, being first detected there in SA at Arno Bay in November 2003.
2. The “race 326” lineage, established following the introduction of pt 326-1,2,3,5,6, which was first detected in 1969-
    - Pt 343-1,2,3,5,6 — The “Oxley” pathotype. Derived from pt 326-1,2,3,5,6 via acquisition of virulence for *Sr5*.
    - Pt 98-1,2,3,5,6 — The “Paterson” pathotype. Derived from pt 343-1,2,3,5,6 via acquisition of virulence for *Sr9g*.

Notes on Cultivars Carrying Genes for Stem Rust Resistance

The stem rust responses of wheat cultivars are not expected to change from those of 2004.

Sr9e	Sunland and Yarralinka (a single isolate of a pathotype virulent for *Sr9e* was identified from WA in 2002).
Sr22	Schomburghk
Sr24	Anlace, Annuello, Babbler, Cunningham, Datatine, Dennis, Giles, Harrismith, Janz, Koelbird, Krichauff, Lang, Mira, Mitre, Mulgara, Pardalote, Perouse, Petrie, QAL2000, QALBis, Sunco, Sunsoft 98, Swift and Worrakatta
Sr26	Chough, Currawong, Darter, Hybrid Mercury, Petrel, Snipe, Sunlin, and Wylah
Sr30	1. (close monitoring required; significant rust may develop even with Sr30-avirulent isolates): Ajana, Arrino (heterogeneous), Kalgarin, Yitpi
	2. Batavia, Brookton, Calingiri, Chara, Cunderdin, EGA Bonnie Rock, EGA Hume, EGA Wedgetail, Frame, H45, Kalannie, Katunga, Lark, Lorikeet, Osprey, Rosella, Silverstar, Sunfield, Sunmist.
Sr31	Grebe, Tennant and Warbler

The gene *Sr2* confers adequate adult plant resistance and is present in the cultivars Arnhem, Batavia (heterogeneous), Baxter, Bowerbird, Brennan, Carnamah, Diamondbird, Dollarbird, Eradu, Glover, Goldmark, Hartog, Kennedy, Kukri, Leichardt, Lowan, Machete, Mackellar, Nyabing, Sunbrook, Sunstate and Tailorbird. Cultivars with *Sr13* (Gutha, Machete, Stiletto, Sunmist and Wialki) are moderately susceptible to moderately resistant. The cultivars Braewood and Sunvale are protected from all stem rust pathotypes by the presence of the gene combination *Sr36* + *Sr38*.

Wheat Leaf Rust (caused by *Puccinia triticina*; formerly *Puccinia recondita* f. sp. *tritici*)
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Epidemiology and Pathotype Distribution

Leaf rust developed to epidemic levels in some crops of the cultivar Marombi in northern NSW in 2005 and there were reports of the disease in wheat crops in south western Victoria. Otherwise, levels of wheat leaf rust were low and the disease was of little impact.

Leaf rust incidence was low throughout WA during the 2005 cropping season. Three pathotypes were isolated from the 13 samples that were successfully subcultured, with pts 104-1,2,3,(6),(7),11 and 104-1,2,3,(6),(7),11 +Lr37 being the most commonly isolated (Table 2).

Nine pathotypes were identified in eastern Australia, five of which are regarded to belong to the group typified by pt 104-2,3,(6),(7),11, which was first detected in Victoria in 1984. One or more members of this group of pathotypes have dominated Australia populations of *P. triticina* since 1990. The original founding pathotype of this group, pt 104-2,3,(6),(7),11, was not detected during the 2003-04 and 2004-05 survey periods, but was isolated in 2005-06 from southern NSW and Victoria (Table 2). Other pathotypes of this group that were isolated from eastern Australia in 2005-06 were pt 104-1,2,3,(6),(7),11 (8 isolates), 104-1,2,3,(6),(7),9,11 (the "Triller" pathotype; 4 isolates from NSW and Victoria), 104-1,2,3,(6),(7),11,13 (the "Lr24" pathotype; 4 isolates from southern NSW, Victoria and SA), and 104-1,2,3,(6),(7),11 +Lr37 (the "VPM" pathotype). The latter was the most commonly isolated and most widespread *P. triticina* pathotype isolated from eastern Australia (Table 2) and was responsible for the leaf rust infections that developed in crops of Marombi in northern NSW.

Of importance during the 2004-05 and 2005-06 *P. triticina* pathogenicity surveys were the detections of two new pathotypes, both considered to have originated from outside Australia: the "Mackellar" pathotype (pt 10-1,3,9,10,11,12), and a second "VPM" pathotype 76-3,5,9,10 +Lr37.

The "Mackellar" pathotype first isolated from Victoria at Bairnsdale in October 2004, was more frequent and more widespread during 2005, being also detected in NSW (Table 2). In NSW, pt 10-1,3,9,10,11,12 was isolated from Merriwa (off cv. Brennan), Narrabri and Tamworth, and in southern NSW from Cooma, Wagga Wagga and Young. It was isolated from various locations throughout Victoria, where it was mainly associated with the cultivars Mackellar, Tennant and Kelalac. Further greenhouse work conducted during 2005 has shown clearly that the Mackellar pathotype is very unusual and must have originated from overseas. One of the most unusual features of this pathotype is that it is avirulent on seedlings of a range of wheat genotypes that in the past have been regarded as lacking effective resistance genes to *P. triticina* (*e.g.* Morocco, Halberd and Tincurrin). This pathotype also produces unusually low infection types on a range of wheat cultivars including Tarsa, Avocet and Harrier. It is apparent that there are at least two uncatalogued seedling resistance genes for which this pathotype is avirulent, and research is currently underway to characterise these genes more fully. The Mackellar pathotype is of concern because it combines virulence for *Lr13* with *Lr1*, *Lr2a* and *Lr26*, a combination that has not been seen in Australia before. An isolated field nursery with current wheat cultivars and the Disease Progress Nursery was established at Richmond in 2005 and infected with the Mackellar pathotype. The data obtained suggest that several wheat cultivars may have increased susceptibility to this pathotype (Brennan (MS), Kukri (MS-S), Mackellar (MS/S-S), Tennant (S)), as may the triticale cultivars Ticket and Treat. Further testing is needed in 2006 to confirm these results.

A presumed mutational derivative of the "Mackellar" pathotype with added virulence for *Lr15* (pt 10-1,3,4,9,10,11,12) was detected from Tamworth in samples collected in late November.

Pathotype 76-3,5,9,10 +Lr37 was first isolated from Inverleigh (Vic) in late July 2006, and was subsequently isolated from samples collected from various locations throughout Victoria with a similar distribution to the Mackellar pathotype. It was then isolated from experimental plots at Temora (early October), Wagga Wagga (mid November), and Tamworth (late November), and was also isolated from a sample of leaf rust reported to have come from a crop of Marombi near Narrabri collected in late November. This pathotype resembles pt 76-1,3,5,10,12, which has been present in eastern Australia since it was first detected in NSW in 1996. The two pathotypes do however differ in virulence/avirulence for *Lr17b*, *Lr20*, *Lr26* and *Lr37*, indicating that pt 76-3,5,10 +Lr37 is very unlikely to be a mutational derivative of pt 76-1,3,5,10,12. There is also some evidence from seedling tests that pt 76-3,5,10 +Lr37 is fully virulent on *Lr17a*, which has only been confirmed in one Australian isolate of *P. triticina* collected to date (pt 104-2,3,6,7 collected from Grafton in 1979). Pathotype 76-3,5,10 +Lr37 combines virulence for *Lr13* with *Lr37*, making it potentially virulent on Braewood, H46 and Rudd. Field nurseries will be established at Cobbitty in 2006 to assess the threat of this pathotype to current cultivars and advanced wheat germplasm.

Notes on the Pathotypes Isolated

The 10 pathotypes of *P. triticina* isolated during 2005-06 are believed to belong to one of four clonal lineages:

1. The "104-2,3,(6),(7),11" lineage. Pt 104-2,3,(6),(7),11 was first detected in a sample collected from Mt Derimut in Victoria in July 1984. We have since detected many single step mutational derivatives and from 1989-2005, with few exceptions one or more of these pathotypes have been the most frequently isolated pathotype in all regions of Australia surveyed-

• Pt 104-1,2,3,(6),(7),11	Derived from pt 104-2,3,(6),(7),11 via acquisition of virulence for *Lr20*. First detected in NSW in 1989 and subsequently spread to all Australian wheat growing regions.
• Pt 104-1,2,3,(6),(7),9,11	The "Triller" pathotype. Derived from pt 104-1,2,3,(6),(7),11 via acquisition of virulence for *Lr26*. This pathotype was first isolated from crops of Triller in southern NSW in 1997 and it has since been detected in all eastern states.
• Pt 104-1,2,3,(6),(7),11 +GH	Derived from pt 104-1,2,3,(6),(7),11 via acquisition of virulence for an uncharaterised seedling resistance gene present in the Lr23 tester Gaza. This uncharaterised resistance gene is effective against other pathotypes within the "104-2,3,(6),(7),11" lineage, and is ineffective to all other Australian pathotypes of *P. triticina* virulent for *Lr23*.
• Pt 104-1,2,3,(6),(7),11,13	The "Lr24" pathotype. Derived from pt 104-1,2,3,(6),(7),11 via acquisition of virulence for *Lr24*. This pathotype was first detected in SA in October 2000, and has since been isolated from all eastern states. It is not known to occur in WA.
• Pt 104-1,2,3,(6),(7),11 +Lr37	The "VPM" pathotype. Derived from pt 104-1,2,3,(6),(7),11 via acquisition of virulence for *Lr37*. This pathotype was first detected in WA early in 2002 from a self sown crop of Camm near Albany. It was subsequently detected in the south eastern corner of SA in December 2002 and is now well established throughout all wheat growing regions of Australia.

2. The “Mackellar” lineage. Pt 10-1,3,9,10,11,12 was first isolated from Victoria at Bairnsdale in October 2004, and is now known to be more widespread in Victoria and NSW. This pathotype has a number of unusual attributes and is regarded as an exotic introduction. One mutational derivative of this pathotype has been detected to date-

    - Pt 10-1,3,4,9,10,11,12 — Derived from pt 10-1,3,9,10,11,12 via acquisition of virulence for *Lr15*. First isolated in 2005 from Tamworth.

3. Pt 76-3,5,9,10 +Lr37. Regarded as an exotic introduction, first isolated from Inverleigh (Vic) in late July 2006, and now present throughout Victoria and in southern and northern NSW.

4. The “Paterson” lineage. Pt 76-1,3,5,10,12 was first detected from NSW in 1996, and is believed to have been introduced to Australia from New Zealand, where it had been present since 1989. This pathotype has now been isolated from Victoria, SA and Tasmania. It has remained at a low incidence but was associated with an epidemic of leaf rust in the western district of Victoria in 1999. A single mutational derivative with virulence for L1 (pt 104-1,3,5,10,12) was isolated from Wanilla (SA) in 2002.

Notes on Cultivars Carrying Genes for Leaf Rust Resistance

It is possible that some cultivars with *Lr17a* (Baxter, heterogeneous; Perenjori), may be more susceptible to a variant of pt 104-1,2,3,(6),(7),11 that has been detected in most wheat growing regions, which appears to have increased but still incomplete virulence for this gene. In addition, there is evidence from seedling tests that the new pt 76-3,5,10 +Lr37 may be fully virulent for *Lr17a*. Tests will be conducted in 2006 to establish whether or not this is the case.

Cultivars with *Lr13* in combination with *Lr1* (Arnhem, Batavia, Bowerbird, Cunderdin, Diamondbird, Glover, Hartog, Kukri, Leichardt, Sunbrook, Sunfield and Tailorbird) or *Lr2a* (Sunmist) could be vulnerable to the new “Mackellar” pathotype. Cultivars with *Lr13* in combination with *Lr23* (EGA Hume, Strzelecki) or *Lr24* (Dennis, Giles, Petrie and Sunsoft 98) are resistant to all pathotypes isolated in 2005. Cultivars carrying *Lr13* and *Lr37* (Braewood, Rudd and Sunstate) may be vulnerable to the new pt 76-3,5,10 +Lr37 and field tests of these cultivars will be conducted in 2006. The combination of *Lr13* and *Lr17b*, found in several winter wheats (Gordon, Mackellar, Paterson) is ineffective in protecting against pts 10-1,3,9,10,11,12; 53-1,(6),(7),10,11,12 (not detected in 2005); and 76-1,3,5,10,12. Declic, which carries *Lr14a* in addition to *Lr13* and *Lr17b*, is resistant to pt 53-1,(6),(7),10,11,12 but seedling susceptible to pts 76-1,3,5,10,12 and 10-1,3,9,10,11,12.

Cultivars with *Lr26* (Grebe, Tennant and Warbler) are at least seedling susceptible to pts 104-1,2,3,(6),(7),9,11, 10-1,3,9,10,11,12 and 76-3,5,9,10 +Lr37. Field data from 2005 suggest that Tennant is rated “S” (susceptible) to the “Mackellar’ pathotype. Mawson is seedling susceptible to pts 104-1,2,3,(6),(7),9,11 and 76-3,5,9,10 +Lr37 but carries an unidentified seedling resistance gene that is effective against pt 10-1,3,9,10,11,12

QAL2000 (*Lr37* + *Lr24*) is resistant to all pathotypes isolated from Australasia during the 2005 survey period.

Cultivars with *Lr21* (Thornbill), *Lr28* (Sunland) and the complementary seedling resistance genes *Lr27*+*Lr31* (Carnamah and Karlgarin) are resistant to all pathotypes isolated in 2005. Genetic studies at PBIC have indicated that Carnamah and Kalgarin should also carry the adult plant resistance gene *Lr12*, which is completely linked to *Lr31*, and in fact may be the same gene.

It is apparent that many cultivars protected previously by *Lr24*, and at least some cultivars protected previously by *Lr37* have some adult plant resistance to pathotypes virulent for these genes.

<u>Wheat Stripe Rust</u> (caused by *Puccinia striiformis* f. sp. *tritici*)
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Disease development

The first samples of stripe rust for 2005 from commercial fields was collected in southern NSW (Tarcutta) from a Whistler crop in early June. This was a relatively early appearance and suggested significant over summer survival of the pathogen.

There were no further reports until late June in the southern NSW region, but the rust was likely to have been developing in some of the early sown fields of Whistler and Wedgetail with ideal conditions of moisture and temperature prevailing during this period. At the end of July, stripe rust was well distributed extending from Temora to Deniliquin in southern NSW, with isolated samples from the north (Coonabarabran, northern NSW) and south (Lake Bolac, Victoria) in eastern Australia. The epidemic developed steadily in August and became widespread and damaging during September and October. It was clear that the major focus of the epidemic in 2005 was the region of southern NSW. Fungicides were again applied across a wide area, especially south eastern Australia, using ground rig and aerial application platforms.

Although the epidemic began later in Queensland, the disease moved quickly and extended its geographical range to include Bauhinia Downs, some 200 Km further north than the previous northern limit reported at Theodore in the epidemics of the mid 1980s. Similarly, the epidemic was relatively slow to begin in Victoria, despite the early samples from Lake Bolac. However, October witnessed the disease widely distributed from southern Victoria through to the Wimmera; the Victorian Mallee seemed only mildly affected. In South Australia, the first reports were very late (early September) but then became quickly widespread from the south east through to the Eyre Peninsula by mid October. In Western Australia, the epidemic was also late in appearing (early September) and limited in development compared to previous seasons.

Pathotype distribution

A sample size of 393 with nearly 90% recovery of viable isolates was a pleasing aspect of the survey. The distribution of pathotypes recorded in 2005 is presented in Table 3. The dominant pathotype, representing nearly 90% of isolates, was again 134 E16 A+ that was first reported in WA in 2002. The adaptation of this pathotype, including its ability to cause disease on previously resistant wheats and its evident aggressive ability to dominate the pathogen population, continues to be a feature in the epidemics of recent years. Several isolates of this pathotype were recovered from grasses, including *Phalaris* and *Bromus* spp.

Pathotypes detected with less frequency included the VPM pathotype (104 E137 A-, Yr17+) and the H45 pathotype (110 E143 A+). The original pathotype detected in 1979 also continued to be recovered at low frequency, as did pathotype 238 E143 A+ that includes virulence for*Yr9*. These pathotypes, with the exception of the VPM rust, are unlikely to cause serious problems. The VPM pathotype continues to be recovered and will pose a threat to wheats such as QAL 2000 and Trident that are essentially only protected by *Yr17.*

Despite the abundance of pathotype 134 E16A+, and the expected appearance of mutant pathotypes when population size is high, there has been just one new pathotype identified to date that has developed from this rust. Pathotype 150 E16 A+ with virulence for *Yr10* was confirmed following observations of unusual rusting in a field of *Yr10*/Bindawarra by Dr Hugh Wallwork at Wolseley, SA. This pathotype should not pose a threat to bread wheats, since the resistance *Yr10* is not widely deployed in commercial cultivars and the pathotype is therefore unlikely to be selected and multiply rapidly. However, greenhouse tests have shown that this pathotype is also virulent on *Yr24* and *Yr26* which have been shown recently to be the same gene. This resistance derives from durum wheat and so the potential impact of this new pathotype on durums will require assessment.

Notes on current resistances

The dominant pathotype 134 E16 A+ is avirulent for *Yr17* and this resistance continues to provide good protection in varieties that carry this gene, *eg* Braewood, Marombi, Rudd, Sunbri, Sunlin, Sunstate, Sunvale. The adult plant resistance *Yr18* also remains effective and is expected to provide protection, especially when combined with other resistances.

A large number of current varieties are noticeably more affected by stripe rust since pathotype 134 E16 A+ has become widespread. Variety responses to this pathotype are regularly reviewed and published as Cereal Rust Reports, and are available from the PBI website.

OAT RUST PATHOGENS

Oat Stem Rust (caused by *Puccinia graminis* f. sp. *avenae*)
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Sample numbers were nearly double of those received in 2004, and yet the total of 41 was still relatively low by historical standards. It was of interest to note that *Pga* virulence was detected again in 2005 after failing to be recovered in 2004. It is clear the *Pga* pathotypes have survived, and the failure to detect them in 2004 was likely a result of low sample size. One sample virulent for *Pga* was detected in WA. This is the first report in this region since 1999, but the possibility of greenhouse contamination cannot be discounted. The implications for the current effectiveness of *Pga* would seem to suggest that virulence will re emerge and cause problems in commercial fields if the pathogen population size resumes to previous levels.

Pathotype group 94 continued to predominate in the relatively small population sampled. The reasons for low population levels of oat stem rust, both in commercial fields and weed situations, continues to be unclear.

Oat Leaf Rust (caused by *Puccinia coronata* f. sp. *avenae*)
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Epidemiology and Pathotype Distribution
The incidence of leaf rust on oats was low in 2005. Forty six samples of leaf rusted oats were received, two of which failed to yield viable isolates. Eighteen pathotypes were identified from the remaining 44 samples (Table 5).

Unlike *P. triticina* and *P. graminis* f. sp. *tritici*, the evolutionary relationships between some of the pathotypes of *P. coronata* f. sp. *avenae* (*Pca*) identified in our surveys are unclear. Research conducted in 2005 has established that the *Pc61* differential Coker 234 carries a second gene for resistance that is effective against some pathotypes. These results also implicate the presence of *Pc61* in cv Warrego, which was thought to carry an uncharacterised resistance gene. We suspect that a number of other differential lines carry genes in addition to the gene for which virulence is being monitored. This makes it difficult to postulate evolutionary relationships between pathotypes of *Pca* and also in translating the data obtained from the differential sets to the response of current commercial oat cultivars.

In general, the isolates of *Pca* over the past 8 years isolated can be placed into one of 4 groups:

1. Pathotypes virulent for differentials carrying *Pc55*, *Pc71* and either or both *Pc38* and *Pc39* (triplet codes 0007, 0107, 0207, 0307 and others).
2. Pathotypes virulent for differentials carrying *Pc58*, *Pc59* and *Pc61* (triplet codes 0011 and 0071).
3. Pathotypes virulent for differentials *Pc39* and *Pc61* (triplet code 4473).
4. Pathotypes avirulent for all differentials carrying these genes (triplet codes 0000 and 0001).

Groups 1 and 2 appear to be clonal lineages, each comprising step-wise mutational derivatives from a common ancestor. Pathotypes in these groups have been commonly isolated from northern NSW and Qld and include those carrying virulence corresponding to the cultivars Culgoa, Cleanleaf, Moola, Graza 68, Warrego, Gwydir and Nugene (Group 1), and Amby and Nobby (Group 2). Pathotypes in Group 3 are also virulent on Amby and Nobby, and one pathotype in this group can attack Bettong and Barcoo.

Pts isolated from SA and WA in 2005-06 tended to be less virulent on the differentials used than those isolated from NSW and Qld, with the most common being pts 0001-0 and 0000-2 (i.e. members of Group 4). Both have been commonly isolated from these regions in recent surveys and whilst pt 0001-0 has also been commonly isolated from NSW and Qld, pt 0000-2 has been isolated less frequently from these states. Virulences were again isolated for the cultivars Bettong and Barcoo (pt 4473-4,6,10 +Bettong +Barcoo, isolated from SA), Gwydir (pt 0071-1,4,7,12 +Gwydir, isolated from Qld), Moola and Graza 68 (*Pc68*; triplet codes 0107 and 0307), and Nugene (seven pathotypes) and Warrego (three pathotypes) (Table 5). Two new pathotypes combined virulence for *Pc68*, Nugene and Warrego (Table 5), suggesting that pyramiding seedling or major resistance genes to *Pca* may not be an effective strategy in achieving durable resistance to this disease. At this stage I believe that all Warrego virulent pathotypes carry virulence for *Pc61* despite all being avirulent on the *Pc61* differential Coker 234.

Notes on Cultivars Carrying Genes for Leaf Rust Resistance

With the exception of cultivar Volta, released in 2003, all current Australian oat cultivars are susceptible to leaf rust. Volta appears resistant to all current pathotypes, however, it was not included in the differential set used in 2005. Greenhouse tests have provided clear evidence of the Warrego resistance (*Pc61*?) plus something else in Volta. Cultivar Taipan, released in 2001, has the Nugene resistance. Some of the cultivars released in Region 1 and regarded at the time of release as resistant to *P. coronata* f. sp. *avenae*, are now susceptible to a range of pathotypes. These cultivars were believed to carry new genes for resistance to *Pca*, but it now seems that the resistance in practically all can be explained on the basis of known resistance genes.

BARLEY RUST PATHOGENS

Barley Stem Rust (caused by *Puccinia graminis*)
R. F. Park and M. Williams
University of Sydney

There were no reports of barley crops affected by stem rust in 2005. Ten samples were received, two of which failed to produce a viable rust isolate (Table 6). Three samples from Hermitage Research Station in Warwick and two samples from Toowoomba comprised either solely the “Scabrum+Sr21” rust or a mixture of the “Scabrum+Sr21” rust and *P. graminis* f. sp. *tritici* pt 343-1,2,3,5,6 (the “Oxley” pathotype). Single samples from Tanney Morel (Qld) and Glen Innes (NSW) were identified as the “Scabrum +Sr21” rust.

Barley Leaf Rust (caused by *Puccinia hordei*)

R. F. Park and M. Williams
University of Sydney

Epidemiology and Pathotype Distribution

The overall incidence of barley leaf rust was low in 2005. Reports of the disease from SA indicated that it was present on the Lower Yorke Peninsula, and from NSW, that it developed in some crops of Baudin and Binalong in the Liverpool Plains region.

Twenty seven samples were received, five of which failed to yield a viable isolate (Table 7). The only pts isolated from WA were 5453P- and the presumed mutational derivative 5453P+ with added virulence for *Rph19* (the "Prior" or "P" gene). Both pts were also common in eastern states along with pts 5452P+ and 220P+. Pts 5453P- and 5453P+ were isolated from Qld during 2005 for the first time, and were also isolated from northern NSW. Both pathotypes were first detected in WA: pt 5453P- was first detected at Esperance in WA in September 2001 and was then subsequently detected in eastern Australia in SA in 2002; pt 5453P+ was first detected at Tincurrin in WA in July 2002, and subsequently in eastern Australia in late October 2003 at Hamilton (Victoria) and Hay (southern NSW). Both have now been detected from all states including Tasmania, where they were both again isolated in 2005 (Table 7).

Two isolates of pt 5452P+ (first isolated from SA) were also recovered from samples collected in Qld (Table 7). Prior to 2005, this pathotype had only been isolated from Region 1 (northern NSW and Qld) once, during the 2003-04 survey period. This pathotype was first detected in Tasmania in 1999, and was detected in SA later that same year. It has now been isolated from all eastern states and not from WA.

Notes on Cultivars Carrying Genes for Leaf Rust Resistance

Many Australian barley cultivars carry seedling genes for resistance to *P. hordei*, however most of these genes are ineffective against pathotypes that currently prevail. Before 1999–2000, the cultivars Tallon and Lindwall (*Rph12*) were regarded as resistant to the pathotypes occurring in Region 1. These cultivars will now need to be monitored carefully because their adult plant responses to the *Rph12* virulent pathotypes detected in the region last year are not well understood. Only Galaxy has effective seedling resistance to leaf rust in Australia, however, not all cultivars will become severely infected and cultivars like Gilbert are known to have good levels of resistance at later growth stages.

The cultivars Baudin (*Rph12*) and Hamelin (no resistance gene), released in WA during 2002, are susceptible pathotypes predominating in all barley growing regions. The newly released cultivar Grout (formerly Cameo/Arupo 31-04) carries *Rph2* and is therefore seedling susceptible to pts 5453P-, 5453P+, and 5452P+.

Barley Grass Stripe Rust (caused by *Puccinia striiformis*)

C. R. Wellings[1] and K.R. Kandel
University of Sydney
([1]on secondment from NSW Department Primary Industries)

Sample numbers were again relatively low, and the pathogen continues to be more frequent in southern NSW and Victoria. Isolates were generally recovered from barley grass, but also certain cultivated barleys including Maritime, Gairdner and Galleon. No crop losses were reported. Some samples of stripe rust on barley yielded the wheat stripe rust pathotype 134 E16 A+.
There continues to be no evidence for stripe rust infection in barley or barley grass in Western Australia.

TRITICALE AND RYE RUST PATHOGENS

R. F. Park, C. R. Wellings[1] , M. Williams, and K.R. Kandel
University of Sydney
([1]on secondment from NSW Department Primary Industries)

With the exception of several stripe rust samples in triticale, there were no reports of rust in commercial crops of triticale or rye in 2005.

MISCELLANEOUS RUST PATHOGENS ON GRASSES

R. F. Park and M. Williams
University of Sydney

A sample of stem rust on *Elymus scabrus* (*Agropyrum scabrum*) collected from Qld failed to yield a viable rust isolate. A sample of stem rust on an unidentified grass collected in Victoria in February 2006 was found to comprise the "scabrum" stem rust pathogen. Samples of rust on a range of grasses did not infect a range of standard differential genotypes of wheat, barley, oats and cereal rye in our greenhouse tests, indicating that the rust present was either not viable or not a cereal attacking rust pathogen. The samples were:

- five samples of leaf rust on *Phalaris* sp. forwarded from Qld, NSW, Victoria and WA
- six samples of leaf rust on unidentified grass species from Victoria, SA and WA
- a single sample of stem rust on rye grass collected in NSW; presumably the pathogen present was *P. graminis* f. sp. *lolli*
- two samples of leaf rust on rye grass collected in Victoria; presumably the pathogen present was *P. coronata* f. sp. *lollii*
- six samples of leaf rust on unidentified grass species from Victoria, SA and WA.

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Table 1. Wheat stem rust isolates identified by region, 1 April 2005 - 31 March 2006

	Number of Isolates							
	Region 1	Region 2	Region 3	Region 4		Region 5	Region 6	
Pathotype	QLD	NNSW	SNSW	VIC	TAS	SA	WA	**TOTAL**
34-1,2,7 +Sr38	-	-	-	2	-	12	12	**26**
34-2,7	-	-	-	-	-	-	1	**1**
98-1,2,3,5,6	-	-	-	-	-	1	-	**1**
98-1,2,3,5,6,7	-	-	-	-	-	-	10	**10**
343-1,2,3,5,6	1	-	-	-	-	-	1	**2**
Total no isolates	**1**	**0**	**0**	**2**	**0**	**13**	**24**	**40**
Total no samples	**1**	**0**	**0**	**4**	**0**	**13**	**33**	**51**
No failed samples	0	0	0	1	0	2	12	

Table 2. Wheat leaf rust isolates identified by region, 1 April 2005 – 31 March 2006

	Number of Isolates							
	Region 1	Region 2	Region 3	Region 4		Region 5	Region 6	
Pathotype	QLD	NNSW	SNSW	VIC	TAS	SA	WA	**TOTAL**
10-1,3,9,10,11,12	-	6	8	19	-	-	-	**33**
10-1,3,4,9,10,11,12	-	3	-	-	-	-	-	**3**
76-3,5,9,10 +Lr37	-	3	2	17	-	-	-	**22**
76-1,3,5,10,12	-	1	1	-	-	-	-	**2**
104-2,3,(6),(7),11	-	-	2	3	-	-	-	**5**
104-1,2,3,(6),(7),11	-	3	1	4	-	-	8	**16**
104-1,2,3,(6),(7),9,11	-	1	1	2	-	-	-	**4**
104-1,2,3,(6),(7),11+GH*	-	-	-	-	-	-	1	**1**
104-1,2,3,(6),(7),11,13	-	-	2	1	-	1	-	**4**
104-1,2,3,(6),(7),11 +Lr37	-	32	8	1	-	3	7	**51**
Total no isolates	**0**	**49**	**25**	**47**	**0**	**4**	**16**	**141**
Total no samples	**1**	**50**	**19**	**27**	**2**	**7**	**16**	**122**
No failed samples	1	13	1	3	2	3	3	

* Differential Gaza carries uncharacterised resistance in addition to *Lr23* that is effective to some pathotypes of leaf rust. This pathotype is fully virulent on Gaza.

Table 3. Stripe rust isolates identified by region, 1 April 2005 – 31 March 2006

	Number of Isolates							
	Region 1	Region 2	Region 3	Region 4		Region 5	Region 6	
Pathotype	QLD	NNSW	SNSW	VIC	TAS	SA	WA	**TOTAL**
104 E137 A-	-	-	2	-	-	-	-	2
104 E137 A- Yr17+	-	1	5	-	-	2	-	8
110 E143 A+	-	-	2	2	-	-	-	4
238 E143 A+	1	1	1	-	-	-	-	3
134 E16 A+	32	38	132	41	-	52	25	320
150 E 16 A+	-	-	-	-	-	1	-	1
BGYR	-	1	11	10	-	1	-	23
Miscellaneous	-	-	2	-	-	-	-	2
Total no isolates	**33**	**41**	**155**	**53**	**0**	**56**	**25**	**363**
Total no samples	**36**	**44**	**172**	**55**	**0**	**59**	**27**	**393**
No failed samples	3	3	17	2	0	3	2	30

Table 4. Oat stem rust isolates identified by region, 1 April 2005 – 31 March 2006

	Number of Isolates						
	Region 1		Region 2		Region 3	Region 4	
Pathotype	QLD	NNSW	SNSW	VIC	SA	WA	**TOTAL**
94-2	-	-	-	-	-	4	4
94-3	-	3	1	3	4	-	11
94-2,3	1	5	3	4	3	4	20
94-2,3,4	1	1	-	-	-	-	2
94-3,4	-	1	-	1	-	1	3
Total no isolates	**2**	**10**	**4**	**8**	**7**	**9**	**40**
Total no samples	**2**	**8**	**9**	**8**	**8**	**6**	**41**
No failed samples	0	0	6	1	3	0	10

Table 5. Oat leaf rust isolates identified by region, 1 April 2005 – 31 March 2006

	Number of Isolates							
	Region 1	Region 2	Region 3	Region 4		Region 5	Region 6	
Pathotype	QLD	NNSW	SNSW	VIC	TAS	SA	WA	**TOTAL**
0000-2	-	-	-	-	-	7	2	**9**
0001-0	1	2	5	1	-	5	9	**23**
0001-2	-	-	-	2	-	1	-	**3**
0001-4	-	-	-	-	-	2	-	**2**
0001-6	-	-	-	-	-	1	-	**1**
0071-0	-	1	-	-	-	1	-	**2**
0071-4	2	2	1	-	-	1	-	**6**
0071-1,4,7,12 +Gwydir	1	-	-	-	-	-	-	**1**
4473-4,6,10	1	-	-	-	-	2	-	**3**
4473-4,6,10 +Bettong +Barcoo	-	-	-	-	-	2	-	**2**
0007-4,6,8,10 +Nugene	1	1	-	-	-	1	-	**3**
0107-4,6,10 +Nugene	-	-	1	-	-	-	-	**1**
0107-4,6,8,10 +Nugene	4	-	-	-	-	-	-	**4**
0107-4,6,10 +Warrego +Nugene	1	-	-	-	-	-	-	**1**
0307-5,6,10 +Nugene	1	-	-	-	-	-	-	**1**
0307-4,5,6,10 +Nugene	2	2	-	1	-	-	-	**5**
0307-4,5,6,10 +Warrego	1	-	-	-	-	-	-	**1**
0307-4,5,6,10 +Warrego +Nugene	1	-	-	-	-	-	-	**1**
Total no isolates	**16**	**8**	**7**	**4**	**0**	**23**	**11**	**69**
Total no samples	**9**	**4**	**9**	**2**	**0**	**11**	**11**	**46**
No failed samples	0	0	1	0	0	0	1	

Table 6. Barley stem rust isolates identified by region, 1 April 2005 – 31 March 2006

	Number of Isolates							
	Region 1	Region 2	Region 3	Region 4		Region 5	Region 6	
Pathotype	QLD	NNSW	SNSW	VIC	TAS	SA	WA	**TOTAL**
Scabrum +Sr21	5	1	-	-	-	-	-	**6**
P. graminis f. sp. *tritici*:								
343-1,2,3,5,6	2	-	-	-	-	-	-	**2**
Total no isolates	**7**	**1**	**0**	**0**	**0**	**0**	**0**	**8**
Total no samples	**8**	**1**	**0**	**0**	**0**	**1**	**0**	**10**
No failed samples	1	0	0	0	0	1	0	

Table 7. Isolates of *Puccinia hordei* identified by region, 1 April 2005 – 31 March 2006

	Number of Isolates							
	Region 1	Region 2	Region 3	Region 4		Region 5	Region 6	
Pathotype	QLD	NNSW	SNSW	VIC	TAS	SA	WA	**TOTAL**
220P+	-	-	-	1	-	1	-	**2**
5452P+	2	-	-	3	3	2	-	**10**
5453P- (+PI366444)	2	2	-	3	4	1	2	**14**
5453P+ (+PI366444)	3	1	-	1	1	1	2	**9**
Total no isolates	**7**	**3**	**0**	**7**	**8**	**4**	**4**	**35**
Total no samples	**7**	**2**	**0**	**4**	**8**	**2**	**4**	**27**
No failed samples	1	0	0	0	3	0	1	